

CLAIMS

1. A fiber optical parametric oscillator comprising:
 - a microstructure fiber having a first end and a second end;
 - a pump wave input to the first end of the microstructure fiber;
 - a reflective mirror for reflecting a wave from the second end of
 - 5 the microstructure fiber back to the microstructure fiber;
 - a diffraction grating tuned to reflect a signal wave of a particular wavelength;
 - a beam splitter disposed between the first end of the microstructure fiber and the diffraction grating, the beam splitter passing
 - 10 the pump wave to the first end of the microstructure fiber, the wave being reflected by the reflective mirror back through the microstructure fiber, the microstructure fiber generating a signal wave and an idler wave that are directed from the first end of the microstructure fiber to the diffraction grating by the beam splitter, the diffraction grating
 - 15 reflecting a signal wave of the particular wavelength back to the beam splitter and from the beam splitter back to the microstructure fiber, and the beam splitter passing a portion of the signal wave to an output of the parametric oscillator.
2. A fiber optical parametric oscillator as recited in claim 1 wherein the wavelength of the pump wave is near the zero-dispersion wavelength of the microstructure fiber.
3. A fiber optical parametric oscillator as recited in claim 1 including a half-wave plate disposed between the beam splitter and the first end of the microstructure fiber.

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4. A fiber optical parametric oscillator as recited in claim 1 including a quarter-wave plate disposed between the reflective mirror and the second end of the microstructure fiber.

5. A fiber optical parametric oscillator as recited in claim 1 including a quarter-wave plate disposed between the diffraction grating and the beam splitter.

6. A fiber optical parametric oscillator as recited in claim 1 wherein the beam splitter passes a portion of the signal wave through a pin hole aperture.

7. A fiber optical parametric oscillator as recited in claim 1 wherein the microstructure fiber is a holey fiber.

8. A fiber optical parametric oscillator as recited in claim 1 wherein the microstructure fiber is a photonic crystal fiber.

9. A fiber optical parametric oscillator as recited in claim 1 wherein the microstructure fiber has elliptical polarization modes.

10. A fiber optical parametric oscillator as recited in claim 1 wherein the microstructure fiber has polarization modes that are not elliptical.

11. A fiber optical parametric oscillator as recited in claim 1 wherein the beam splitter is a polarization beam splitter.

12. A fiber optical parametric oscillator as recited in claim 1 having phase matched four-wave mixing in the microstructure fiber.

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13. A fiber optical parametric oscillator as recited in claim 1 wherein the reflective mirror is movable.

14. A fiber optical parametric oscillator as recited in claim 1 including a high power laser source for providing the pump wave.

15. A fiber optical parametric oscillator as recited in claim 1 wherein the wave passed to the input of the first end of the microstructure fiber is equally horizontally and vertically polarized.

16. A fiber optical parametric oscillator as recited in claim 1 wherein the wave passed to the input of the first end of the microstructure fiber is not equally horizontally and vertically polarized.

17. A fiber optical parametric oscillator as recited in claim 1 wherein the optics include free-space optics.

18. A fiber optical parametric oscillator comprising:
a microstructure fiber having a first end and a second end;
a pump wave input to the first end of the microstructure fiber;
a movable reflective mirror for reflecting a wave from the second
5 end of the microstructure fiber back to the microstructure fiber;
a diffraction grating tuned to reflect a signal wave of a particular wavelength;
a beam splitter disposed between the first end of the microstructure fiber and the diffraction grating, the beam splitter passing
10 the pump wave to the first end of the microstructure fiber, the wave being reflected by the reflective mirror back through the microstructure fiber, the microstructure fiber generating a signal wave and an idler wave that are directed from the first end of the microstructure fiber to

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15 the diffraction grating by the beam splitter, the diffraction grating reflecting a signal wave of the particular wavelength back to the beam splitter and from the beam splitter back to the microstructure fiber, and the beam splitter passing a portion of the signal wave to an output of the parameter oscillator.

19. A fiber optical parametric oscillator as recited in claim 18 including a half-wave plate disposed between the beam splitter and the first end of the microstructure fiber.

20. A fiber optical parametric oscillator as recited in claim 18 including a quarter-wave plate disposed between the diffraction grating and the beam splitter.

21. A fiber optical parametric oscillator as recited in claim 18 wherein the wavelength of the pump wave is near the zero-dispersion wavelength of the microstructure fiber.

22. A fiber optical parametric oscillator as recited in claim 18 wherein the microstructure fiber has elliptical polarization modes.

23. A fiber optical parametric oscillator as recited in claim 18 wherein the microstructure fiber has polarization modes that are not elliptical.

24. A fiber optical parametric oscillator comprising:
a microstructure fiber having a first end and a second end;
a pump wave input to the first end of the microstructure fiber;
a movable reflective mirror for reflecting a wave from the second
5 end of the microstructure fiber back to the second end of the microstructure fiber;

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a diffraction grating tuned to reflect a signal wave of a particular wavelength;

10 a beam splitter disposed between the pump wave input and the first end of the microstructure fiber and between the diffraction grating and the microstructure fiber; and

 a half-wave plate disposed between the beam splitter and the first end of the microstructure fiber.

25. A fiber optical parametric oscillator as recited in claim 24 wherein the wavelength of the pump wave is near the zero-dispersion wavelength of the microstructure fiber.

26. A fiber optical parametric oscillator as recited in claim 24 including a quarter-wave plate disposed between the diffraction grating and the beam splitter.

27. A fiber optical parametric oscillator as recited in claim 24 wherein the microstructure fiber has elliptical polarization modes.

28. A fiber optical parametric oscillator as recited in claim 24 including a high power laser source for providing the pump wave.

29. A fiber optical parametric oscillator comprising:

 a microstructure fiber having a first end and a second end, the microstructure fiber having a zero-dispersion wavelength;

5 a pump wave input to the first end of the microstructure fiber, the pump wave having a wavelength near the zero-dispersion wavelength of the microstructure fiber;

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a movable reflective mirror for reflecting a wave from the second end of the microstructure fiber back to the second end of the microstructure fiber;

10 a diffraction grating tuned to reflect a signal wave of a particular wavelength;

a beam splitter disposed between the pump wave input and the first end of the microstructure fiber and between the diffraction grating and the microstructure fiber; and

15 a half-wave plate disposed between the beam splitter and the first end of the microstructure fiber.

30. A fiber optical parametric oscillator as recited in claim 29 including a quarter-wave plate disposed between the diffraction grating and the beam splitter.

31. A fiber optical parametric oscillator as recited in claim 29 wherein the microstructure fiber has elliptical polarization modes.

32. A fiber optical parametric oscillator as recited in claim 29 wherein the microstructure fiber has polarization modes that are not elliptical.

33. A fiber optical parametric oscillator as recited in claim 29 having phase matched four-wave mixing in the microstructure fiber.

34. A fiber optical parametric oscillator as recited in claim 29 including a high power laser source for providing the pump wave.

35. A fiber optical parametric oscillator comprising:

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a fiber optical ring cavity, at least a portion of which is formed of a microstructure fiber, the cavity having an associated repetition rate;

5 a pump wave coupled to an input of the cavity, the pump wave having a repetition rate that is a multiple of the cavity repetition rate; and

a tunable optical bandpass filter in the ring cavity.

36. A fiber optical parametric oscillator as recited in claim 35 wherein the oscillator is synchronously mode-locked at a cavity fundamental frequency that is the same as the fundamental rate of the pump wave.

37. A fiber optical parametric oscillator as recited in claim 35 wherein the oscillator is synchronously mode-locked at a cavity fundamental frequency that is at a subharmonic of the pump wave.

38. A fiber optical parametric oscillator as recited in claim 35 herein the oscillator is synchronously mode-locked at a cavity fundamental frequency that is at a high harmonic of the pump wave.

39. A fiber optical parametric oscillator as recited in claim 35 wherein the microstructure fiber has a positive dispersion slope.

40. A fiber optical parametric oscillator as recited in claim 35 wherein the microstructure fiber has a negative dispersion slope.

41. A fiber optical parametric oscillator as recited in claim 35 wherein the pump wave is coupled to an input of the cavity by a bandpass wavelength division multiplexer.

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42. A fiber optical parametric oscillator as recited in claim 35 including a fused coupler in the ring cavity to provide an output of the fiber optical parametric oscillator.

43. A fiber optical parametric oscillator as recited in claim 35 including a mode locked fiber laser providing the pump wave.

44. A fiber optical parametric oscillator as recited in claim 35 including a fiber laser with a tunable repetition rate for providing the pump wave.

45. A fiber optical parametric oscillator as recited in claim 35 having four-wave mixing in the microstructure fiber.

46. A fiber optical parametric oscillator as recited in claim 35 wherein the microstructure fiber has elliptical polarization modes.

47. A fiber optical parametric oscillator as recited in claim 35 wherein the microstructure fiber has polarization modes that are not elliptical.

48. A fiber optical parametric oscillator comprising:
a fiber optical ring cavity, at least a portion of which is formed of a microstructure fiber;

5 a pump wave coupled to an input of the cavity, to provide synchronously pumped parametric oscillation in the cavity; and

wherein the fiber optical parametric oscillator is tunable over a range in a 1550 nm band.

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49. A fiber optical parametric oscillator as recited in claim 48 wherein the oscillator is synchronously mode-locked at a cavity fundamental frequency that is the same as the fundamental rate of the pump wave.

50. A fiber optical parametric oscillator as recited in claim 48 wherein the oscillator is synchronously mode-locked at a cavity fundamental frequency that is at a subharmonic of the pump wave.

51. A fiber optical parametric oscillator as recited in claim 48 wherein the oscillator is synchronously mode-locked at a cavity fundamental frequency that is at a high harmonic of the pump wave.

52. A fiber optical parametric oscillator as recited in claim 48 including a tunable optical bandpass filter in the ring cavity.

53. A fiber optical parametric oscillator as recited in claim 48 wherein the parametric oscillator is tunable over a range of at least 100 nm.

54. A fiber optical parametric oscillator as recited in claim 48 wherein the parametric oscillator is tunable over a range of at least 120 nm.

55. A fiber optical parametric oscillator as recited in claim 48 wherein the pump wave is coupled to an input of the cavity by a bandpass wavelength division multiplexer.

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56. A fiber optical parametric oscillator as recited in claim 48 including a fused coupler in the ring cavity to provide an output of the fiber optical parametric oscillator.

57. A fiber optical parametric oscillator as recited in claim 48 including a mode locked fiber laser providing the pump wave.

58. A fiber optical parametric oscillator as recited in claim 48 including a fiber laser with a tunable repetition rate for providing the pump wave.

59. A fiber optical parametric oscillator as recited in claim 48 having four-wave mixing in the microstructure fiber.

60. A fiber optical parametric oscillator as recited in claim 48 wherein the microstructure fiber has a positive dispersion slope.

61. A fiber optical parametric oscillator as recited in claim 48 wherein the microstructure fiber has a negative dispersion slope.

62. A fiber optical parametric oscillator as recited in claim 48 wherein the microstructure fiber has elliptical polarization modes.

63. A fiber optical parametric oscillator as recited in claim 48 wherein the microstructure fiber has polarization modes that are not elliptical.